Biomining

INL has a long-standing multi-disciplinary program in biological mining. Biomining research has included biological approaches to the extraction and recovery of metal from ores, controlling acid drainage, and biological processing of phosphate minerals. Initial work focused on extraction and recovery of cobalt and other metals from low-grade ores but has expanded to include sulfidic ores of gold, copper, zinc and nickel, and heap, stirred tank and thermophilic bioleaching.

Control of sulfide mineral leaching requires understanding the microbial ecology of these environments. Microbial techniques used to speciate and enumerate microbes include an overlay plating method to isolate bacteria typically difficult to grow, and 16S rRNA techniques, including real-time PCR, and fluorescent *in situ* hybridization. These methods are applied to mesophilic, moderately thermophilic, and extremely thermophilic organisms. These techniques are used to monitor microbial populations and population shifts due to environmental changes such as pH, temperature and dissolved oxygen shifts. Such fluctuations in stirred tank and column processes, and in heap and dump leaching systems, can thereby be understood and controlled.

INL researchers developed biological strategies for leaching of arsenopyrite ores (including the use of genetic engineering to improve arsenic resistance in acidophilic bacteria), techniques for acid rock drainage mitigation, approaches to cyanide degradation in gold mining operations, bioprocesses for selenium and chromium reduction, and options for metal sorption from process or waste waters. INL organized and hosted the International Biohydrometallurgy Symposium at Jackson Hole, Wyo, in 1989 and 1993.

Bioprocessing of phosphate containing minerals to recover phosphate has been studied. Microbes, such as *Burkholderia cepacia,* that promote separation of phosphate from gangue minerals, have been isolated, characterized and applied.

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Selected Publications/Presentations/Patents

Aston, J.E., W.A. Apel, B.D. Lee, and B.M. Peyton. 2010. Effects of Cell Condition, pH, and Temperture on Lead, Zinc, and Copper Sorption to *Acidithiobacillus caldus* BC13. Journal of Hazardous Material. 184:34-41

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